



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|--|-------------|----------------------|---------------------------------|------------------------|
| 10/691,746 | 10/22/2003 | Dimitry Shur | 8640 Y1 USA/PDC/NPD | 1979 |
| 57605 7590 03/31/2010 APPLIED MATERIALS, INC. C/O SONNENSCHN NATH & ROSENTHAL LLP P.O. BOX 061080 WACKER DRIVE STATION, WILLIS TOWER CHICAGO, IL 60606-1080 | | | EXAMINER JOHNSTON, PHILLIP A | |
| | | | ART UNIT 2881 | PAPER NUMBER |
| | | | MAIL DATE 03/31/2010 | DELIVERY MODE PAPER |

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

| | | | |
|------------------------------|--|------------------------------------|--|
| Office Action Summary | Application No. 10/691,746 | Applicant(s) SHUR ET AL. | |
| | Examiner PHILLIP A. JOHNSTON | Art Unit 2881 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 09 February 2010.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,3-6 and 8-10 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,3-6 and 8-10 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 27 October 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date <u>2-9-2010</u> | 6) <input type="checkbox"/> Other: _____ |

Detailed Action

1. This Office Action is submitted in response to the RCE/Amendment filed 2-9-2010, wherein claims 2, 7 and 11-18 have been canceled; claims 1 and 6 have been amended. Claims 1, 3-6 and 8-10 are pending.

Examiners Response to Arguments

2. Regarding the applicants argument that the previously applied references fail to teach the newly amended limitation regarding detection electrons that are scattered at angles less than eighty degrees, the teaching is provided by the new reference USPN 3,849,659 to O'Keefe. See the rejection below.

Claims Rejection – 35 U.S.C. 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1, 3-6 and 8-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Essers USPN 6,590,210, in view of Chen, USPN 6,064,486, in further view of Bowes, USPN 6,778,275, and in even further view of O'Keefe, USPN 3,849,659.

Regarding claim 1, Essers discloses a method for using a scanning electron microscope in metrology applications to perform the following steps;

(a) irradiating a specimen for metrology (irradiating an inspected object) by diverting the primary electron beam from an optical axis to an axis that is parallel to the optical axis and

then diverting the beam back again to the original optical axis (note Figure 9) before striking the specimen. Col. 5, line 37-61, and Col. 21, line 43-54,

(b) detecting reflected or scattered electrons with first and second in-lens detectors, where the detectors are positioned (note Figures 6 to 8) to allow electrons that pass through an aperture in a first in-lens detector 18 to be detected by a second in-lens either detector 51 or 74. Col. 7, line 5-32 and Col. 15, line 5-32,

(c) performing automated metrology measurements in semiconductor production, which can include measuring overlay error. Col. 2, line 47-57.

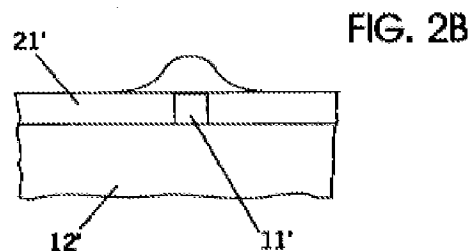
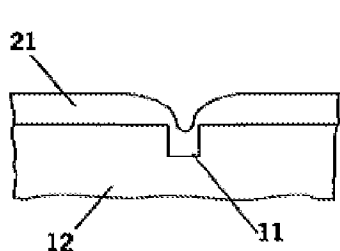
Essers discloses the use of a SEM in the semiconductor industry for automated monitoring in production of metrology applications which require accurate centering or alignment of the beam along the optical axis by using alignment coils and their control devices, and also includes measuring overlay error. See Col. 2, line 50-57; Col. 5, line 49-61; and Col. 6, line 17-24.

However, Essers fails to explicitly disclose that the inspected object has a first feature formed on a first layer, a second feature formed on a second layer, and the second feature is buried under the first layer and affects a shape of an area of the first layer, but the first feature and second feature are not overlapping.

Chen discloses detecting a position of a new alignment mark on a substrate during an alignment phase of integrated circuit fabrication and during a metrology phase of integrated circuit fabrication. Specifically, overlay metrology is performed to determine how well one layer aligns to a previous layer. Thus, metrology compares an alignment mark, generally referred to as a metrology mark, on a current layer with an alignment mark on the previous

layer, both of which are on a substrate. The metrology tool detects the alignment marks and determines the positions of the current and previous alignment marks. From these positions, an overlay may be calculated. Accordingly, the present invention may be used to detect the positions of the current and previous alignment marks during the metrology phase, as well as to detect the position of alignment marks during the alignment phase. See also Col. 6, line 47-53.

Chen also discloses at Col. 5, line 3-10 a primary electron beam directed through a coating 21 to an alignment mark having feature 11 below the surface of a sample 12, where the second layer of sample 12 includes a second feature (11 or 11') buried under the first layer 21 or 21', where the second feature effects the shape of an area in the first layer due to asymmetries of the coating process as shown in Figures 2A and 2B below. See also Col. 5, line 46-64.



Chen modifies Essers to provide alignment of one patterned layer to underlying layers is attributed to variations in the overlay of the various mask's used in lithography processing of semiconductor devices. Col. 1, line 39-44.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made that Essers would use the alignment technique of Chen to measure the overlay across a multilayered alignment mark, in order to provide beam position

determination with high accuracy thereby improving the registration accuracy of the layers to the substrate during integrated circuit processing. Col. 1, line 23-38.

The combination of Essers and Chen teaches the use of a multiple layered alignment mark, but fails to teach an intermediate layer between the first layer and the second layer where the features are not overlapping.

Bowes discloses at Col. 11, line 62-67; and Col. 12, line 1-13, an overlay measurement mark having a box-in-box structure with a first layer 640 including feature 410 and a second layer 630 with plural features located below the first layer, some of which are not overlapping (430, 450 etc.) as shown in Figure 6 below. Bowes also discloses at Col. 12, line 6-13, that the overlay mark structure includes additional intermediary layers.

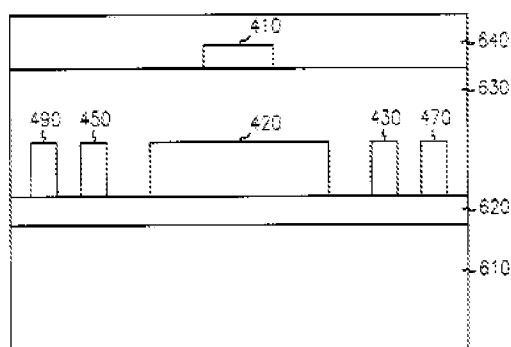


FIG. 6

Bowes modifies the combination of Essers and Chen to provide a layered mark for measuring layer misalignment induced by process fabrication steps and for estimating overlay errors. [0012] and 0053].

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made that the combination of Essers and Chen would use the multi-layered alignment mark of Bowes to determine beam misalignment in a scanning electron

microscope and adjust the beam along the optical axis to correct for aberrations thereby helping to insure that the semiconductor devices fabricated by the beam perform well.

Regarding the newly amended limitation "wherein said electrons are scattered or reflected at angles less than eighty degrees with respect to a surface of the inspected object".

Essers discloses detecting backscattered electrons with semiconductor detector 18, and using backscattered electrons in imaging to reduce the influence of charge buildup in the metrology equipment. at Col. 17, line 22-49

O'Keeffe discloses using backscattered electrons for alignment of an electron beam, where the electrons are backscattered at an angle between 40° and 75° to the axis of incidence.

Okeefe modifies the combination of Essers, Chen and Bowes to provide a method of aligning an electron beam by detecting backscattered electrons from an alignment mark.

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made that the combination of Essers, Chen and Bowes would detect backscattered electrons at the angles taught in O'Keeffe in order to provide automatic alignment of the beam thereby obtaining the precision required in the manufacturing of integrated circuit devices.

5. Regarding claims 3 and 4, the combination of Essers, Chen and Bowes disclose the method step of directing the beam to the second feature and detecting scattered electrons from it, as described above regarding claim 1.

6. Regarding claim 6, the combination of Essers, Chen and Bowes discloses the claimed method steps, as described above regarding claim 1, wherein Essers discloses

directing the beam of an SEM to an inspected object to perform metrology measurements and deflecting the beam through an orifice that lies on an axis parallel to the optical axis, which is then deflected back to the optical axis to irradiate a specimen. Essers also teaches use of first and second in-lens detectors, positioned so that electrons pass through an aperture in the first in-lens detector and are detected by a second in-lens detector,

Chen discloses an alignment mark for measuring overlay having a first feature formed on a first layer of the inspected object, a second feature formed on a second layer of the inspected object, and an intermediate layer positioned between the first and second layers, wherein the second feature is buried under the first layer.

Bowes discloses an overlay alignment mark having a first feature located on a first layer and a second feature located on the second layer such that they are not overlapping.

Essers would be motivated to modify the SEM apparatus with the alignment mark configurations of Chen and Bowes because Essers describes the use of a SEM the semiconductor industry for automated monitoring in production of metrology applications and notes the importance of accurately centering the beam along the optical axis by using alignment coils and their control devices.

7. Regarding claims 5 and 10, the combination of Essers and Chen discloses the steps of these method claims, as described above regarding claims 1 and 6. Essers also discloses at Col. 3, line 38-50 that charge buildup occurs during irradiation; however the effect of charge buildup is reduced by using high energy backscattered electrons.

Essers further discloses adjusting the parameters of the apparatus such as beam energy to improve detection efficiency of sensitive specimens, from which one of ordinary

skill in the art would recognize that adjusting beam energy would include determining the depth required for the beam to interact with a second feature and detecting the electrons scattered from it. See Col. 2, line 3-7 and Col. 18, line 34-46.

However, Essers fails to disclose a preliminary step of charging the second feature.

One of ordinary skill in the art would recognize that obtaining SEM images using high energy backscattered electrons in accordance with Essers, provides the ability to detect features in both upper and lower layers while the specimen is undergoing charge build-up, which is equivalent to performing a preliminary step of charging.

Therefore one of ordinary skill in the art at the time the invention was made would recognize that charge build up to occur in the layers of the sample in accordance with Essers since backscattered electrons can be detected with a high signal to noise ratio without charge neutralization, thereby obtaining high resolution images in metrology measurements.

8. Regarding claims 8 and 9, the combination of Essers, Chen and Bowes disclose the method step of directing the beam to a multilayered alignment mark and detecting the electrons scattered from its surfaces, as described above regarding claims 1 and 6.

Conclusion

10. Any inquiry concerning this communication or earlier communications should be directed to Phillip Johnston whose telephone number is (571) 272-2475. The examiner can normally be reached on Monday-Friday from 7:00 am to 4:00 pm. If attempts to reach the examiner by telephone are unsuccessful, the examiners supervisor Robert Kim

can be reached at (571)272-2293. The fax phone number for the organization where the application or proceeding is assigned is 571 273 8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

PJ

March 29, 2010

/Phillip A Johnston/

Examiner, Art Unit 2881

Application/Control Number: 10/691,746
Art Unit: 2881

Page 10

Application/Control Number: 10/691,746
Art Unit: 2881

Page 11